Tailoring Optical and Rheological Properties of an epoxy acrylate based Host-Guest System

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Introduction and Motivation

We are developing new hybrid polymer systems based on methacrylates. **Tailoring** prepolymer properties like **viscosity** enables them for different shaping and molding processes:

- Inkjet, offset and flexographic printing
- Nano-imprint-lithography (NIL)
- Reaction molding

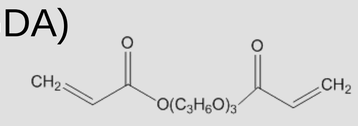
In addition we are able to **adjust** the **refractive index** which is important to reduce coupling losses due to reflections between two optical components (e.g. waveguides and LEDs). We are also able to achieve the necessary **difference in refractive indices** between core and cladding of potential waveguides.

Polymerization is performed under **UV-light** which gives the opportunity to use even processes like inkjet printing where high temperatures during the shaping processes occur.

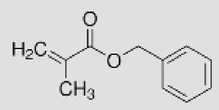
Materials

Polymer matrix

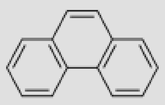
- Main polymer: Syntholux®, an epoxy acrylate, diluted with 80% tripropylene glycol diacrylate (TPGDA)



- Comonomer:
  1) ethylene glycol dimethacrylate (EGDMA)
  2) Benzyl methacrylate (BMA)
     -> Crosslinking agent for higher stability
     -> Diluting monomer for lower viscosity



- Dopant: phenanthrene (electron rich)



Initiators

- UV: Diphenyl(2,4,6-trimethylbenzoyl)phosphine oxide
- Thermal: Dilauroyl peroxide

Experimental

Sample preparation

- Casting mould
- FEP foils
- Glass plates

Curing

- UV-LEDs
- 405 nm
- 8 min @ 25%

Refractive index

- 3 samples each
- Wavelengths: 450, 589, 680 nm
- Temperature: 20˚C

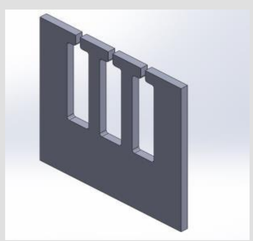


Figure 1: Casting mould out of silicon

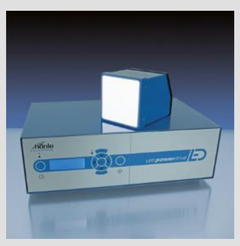


Figure 2: UV lamp, LED Spot 100, Hönle[1]

[1]hönle – uv technology, Gräfelfing, Germany

Figure 3: Abbe refractometer, ATAGO DR-M 2/1550[2]

[2]Leo Kübler GmbH, Karlsruhe, Germany

Results I – Viscosity adjustment

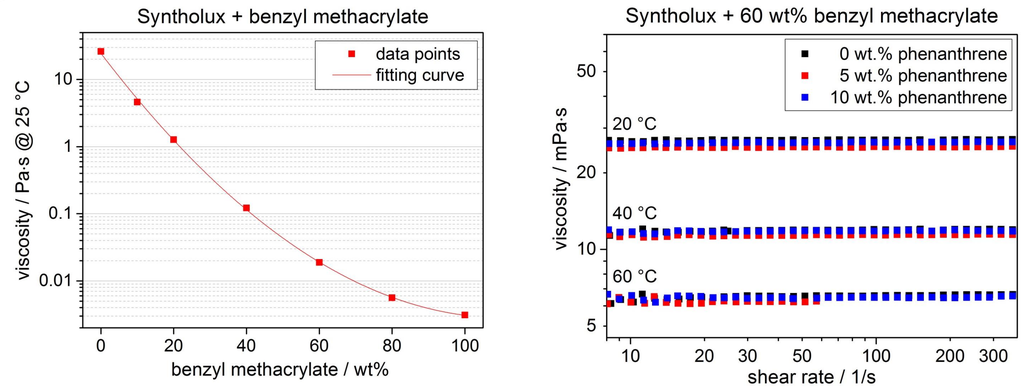


Figure 4/5: **Viscosity vs BMA** (left) **and vs phenanthrene content** (right)

Results II – Optical adjustment / properties

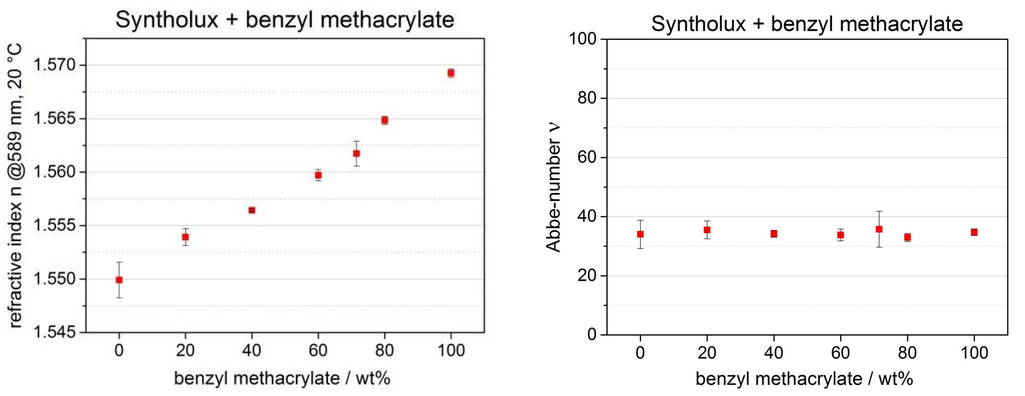


Figure 6/7: **Refractive index / Abbe number** (left / right)

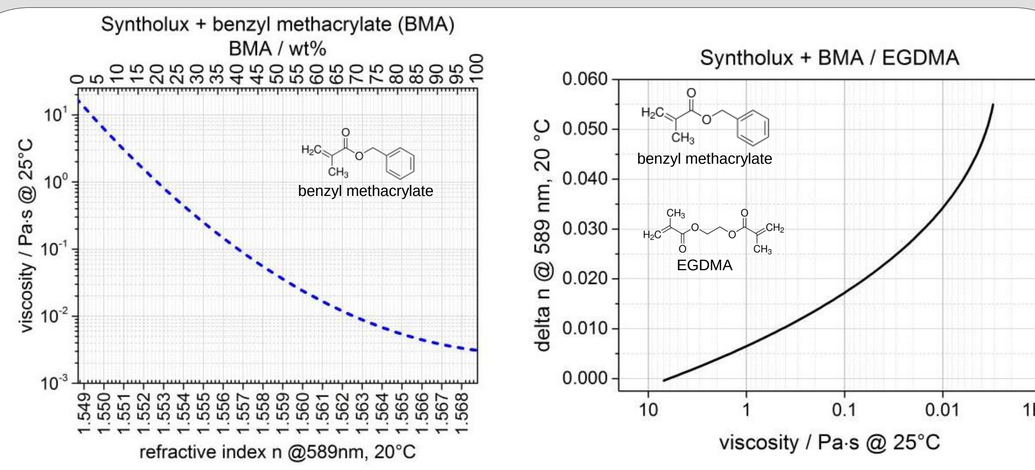


Figure 8/9: **Refractive index vs viscosity / delta n** (left / right)

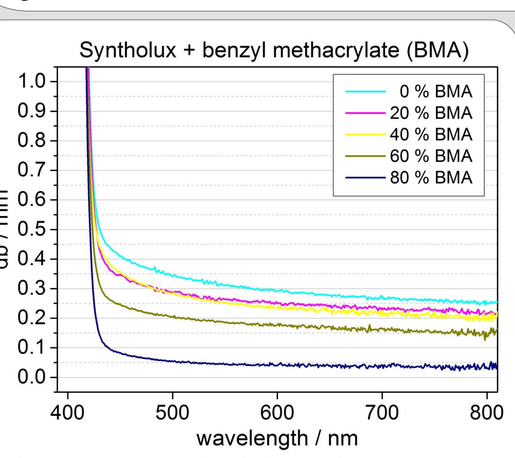


Figure 10: **Optical damping**

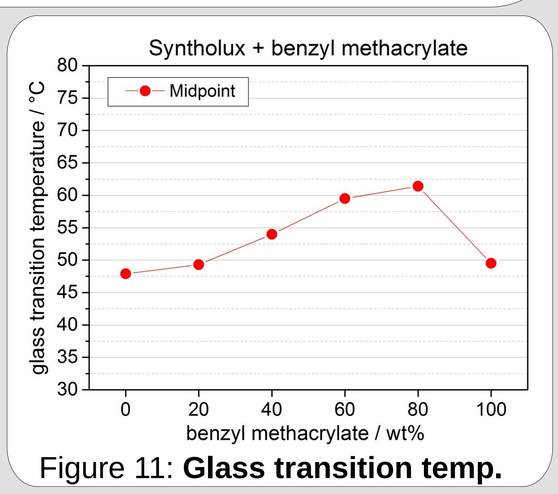


Figure 11: **Glass transition temp.**

Summary

- ✓ Wide range of viscosity adjustment: 4 mPa·s < η < 48 Pa·s
- ✓ Refractive index tunable: 1.51 < n < 1.58
- ✓ Optical damping as low as 0.05 db/mm
- ✓ Glass transition temperature up to 62 °C

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